BOTANY.

Protoplasmic Physics.—Prof. Pfeffer, of Leipzig, has published [1] the results of his studies on the taking up and extrusion of solid substances by the plasmodia of Myxomycetes, especially of *Chondroderma difforme*. He concludes that, contrary to the more generally accepted view, the inclusion of solid bodies is due not at all to reaction to chemical or contact stimulus, but is a purely mechanical process due to the weight of the body, or to its resistance to the forward movement of the plasmodium. The plasma-membrane closes behind the included object like a film of oil from which a needle is withdrawn.

Indifferent or insoluble substances are not infrequently enclosed in vacuoles, from which they may pass back into the protoplasm; but substances which can furnish nutrient material to the protoplasm are never seen in vacuoles. In from one to four days all foreign bodies are thrown out, even such as are still capable of furnishing abundant nutritive material. Bodies enclosed in vacuoles are thrown out by the rupture of the vacuoles after they have migrated to the margin of the plasmodium. Extrusion of foreign bodies occurs only during the active movementof plasmodia, and is chiefly referable to their resistance to this movement. It is, as yet, wholly impossible to explain why one body follows the movements of the protoplasm, while others are thrown out. In the study of protoplasm within the cell-wall the author observed in the root-hairs of *Trianea bogotensis* that precipitates formed in the cell-sap by the action of methyl-blue were taken up by the protoplasm, as well as crystals of calcium oxalate, and he saw both sorts of bodies returned to the vacuoles. He considers that, in view of the interchange observed, it cannot be regarded as certain that a given element of the cell-contents has arisen where it is seen in any single case.

The same author concludes, in a paper following the last,[2] that vacuoles may arise anywhere in the cytoplasm, not necessarily by division, but independently, in spite of the views of the De Vries school. In the plasmodia of Chondroderma, he has observed all the intermediate conditions between pulsating and inactive vacuoles, and has succeeded by very ingenious experiments in producing vacuoles artificially. This was done by placing a plasmodium in a saturated aqueous solution of asparagin, or some other suitable substance, which contained some

[1] Ueber Aufnahme und Ausgabe ungelöster Körper. Abhandl. d. Math.—Phys. Cl. d. Sächs Ges. de Wissensch. Bd. XVI., p. 149. (Bot. Centralbl., XLIV., 180.)

[2] Zur Kenntniss der Plasmahaut und der Vacuolen, etc.; *l. c.* p. 185. (Bot. Centralb., *l. c.*)

undissolved granules of the same substance. After it had taken up some of these granules the plasmodium was removed to pure water, when a vacuole was slowly formed about each granule, in consequence of its gradual evolution. These artificial vacuoles differed in no respect, except in size, from the natural ones, but even showed, in some cases, slight pulsations. They were seen to divide and to fuse with each other and with pulsating vacuoles, and were formed even in chloroformed plasmodia. It is evident that these vacuoles cannot be dependent on a special organ, the tonoplast of De Vries, for their formation.

Pfeffer considers the hyaloplasm and the granular plasma of the cell protoplasm to be essentially the same, and to differ merely in the presence or absence of granules of most various composition, some of which are foreign substances. He has seen the change from one to the other condition, and has observed the formation of vacuoles in both granular and hyaline plasma. He considers the existence of a plasma-membrane, distinct from the remaining cytoplasm, very probable, in view of the peculiar osmotic phenomena presented by the cytoplast. It is uncertain whether this membrane owes its origin to a definite surface stretching or whether the contact of water is also necessary. Vital activity does not appear to be essential either to its formation or to the manifestation of plasticity in the protoplast.—J. E. HUMPHREY, *Amherst, Mass.*

Alcoholic Material for Laboratory Work in Systematic Botany.—It is now generally recognized that laboratory practice or field work is indispensable to effective instruction in all the natural sciences. Botany deals with material that is especially adapted to training the powers of observation. The translation of the characters of a stem, leaf, or flower into appropriate language will give the student a habit of careful investigation, as well as facility in description.

Plants direct from the field are generally considered to be in the best possible condition for use in the laboratory. It is a difficult matter sometimes, however, to shape courses of instruction so as to have plants in flower just at the time when they are needed. During the spring there is an abundance; but in the fall and winter, how shall material be provided? To furnish a class of thirty or more from a greenhouse is too expensive; moreover, plants will not always blossom in the greenhouse just when desired. The plan is sometimes adopted of pressing enough specimens to supply each member of the class with a specimen of the species to be studied. There are serious objections, however, to this plan. In the first place, specimens collected in such a wholesale way are not apt to be satisfactory. All

specimens should be as complete as possible when they are to be used by students. Second, dry material is very difficult to dissect. Soaking in water will soften the tissue, but renders it too soft and pulpy to dissect nicely. A third objection to this plan is the expense of collecting so large an amount of material every year, for, in most cases, at least one specimen will be used up by a student in a single study.

Having experienced the above difficulties in the laboratory, we have been trying in various ways to overcome them. The work of the winter in the laboratory is to make a study of typical species of several orders, among which are the Rosaceæ, Ranunculaceæ, Nymphæaceæ, and Leguminosæ. This work has been preceded by similar studies in the orders Compositæ, Gramineæ, and Cyperaceæ in the fall, and by general work in plant analysis during the previous spring term. The course is accompanied by lectures. Now, instead of pressing as many specimens of each species as is intended for study each year, we pursue the following plan: The species to be studied are selected. As many specimens of each species as there will be students in the laboratory at each session are pressed, taking great pains to have each specimen as complete as possible, and also pressing and drying them promptly, so as to preserve the colors. These specimens are mounted on heavy card-board sheets. A convenient size for the sheets is 14x22 inches. The specimens are fastened to the card-board with fish-glue, or may be fastened with narrow strips of gummed paper; I think the fish-glue is preferable. The mounted specimen shows the whole plant if possible. The fruit is also shown. When the plant is too large to press entire the flower, fruit, various forms of leaves, and a piece of the root and stem are mounted. If the plant has medicinal properties, the part which is medicinal is shown as it appears in commerce. If any part of the plant be of economic importance, as the fibre of flax or the bast of basswood, these are shown.

Such a set of permanent, mounted specimens duplicates plants growing fresh in the field sufficiently for the purposes of systematic study. The cards, when in use, are suspended from an arm by "bull-dog hooks," which may be obtained at any bookstore. The arms are about one foot long, and, as the tables are arranged in our laboratory, can be fastened to the window casing. Very nice horizontal arms with attachment can be obtained of furniture dealers.

To go along with these mounted specimens a sufficient quantity of flowers and young fruits for dissection to supply the class is collected and preserved in alcohol until they are to be used. So far, our experience has been that alcohol is the best preservative for this tissue, as

well as for tissue designed for histological purposes. The fresh material is put in 50 per cent. alcohol, and then the strength of the alcohol is gradually increased until it is at least 80 per cent. A very effective way of hardening is to place the material in a straight glass vessel, such as a straight beaker having a membrane of chamois-skin for a bottom. This is placed in another jar. This makes a vessel within a vessel. The outer one contains 95 per cent. alcohol; the inner contains the material and just sufficient 50 per cent. alcohol to cover it. Gradually the alcohol in the inner vessel will become stronger, until it is sufficiently strong to preserve the tissue. This is Schultze's apparatus. Hardening in this way saves alcohol and time. Where material is changed from weaker to stronger there is always left over a considerable quantity of alcohol too weak to use for permanent storage. Where the Schultze apparatus is used, the spirit in which the material is when hardened is strong enough to preserve it indefinitely. We store our hardened material in ordinary fruit jars. It is perfect in all respects except color, the loss of which is more of an advantage than disadvantage. The tissue is clear and cuts smoothly. By keeping it slightly moistened with the preserving fluid while dissecting, it preserves its shape as long as desired. It is less pulpy than fresh tissue, and much more manageable than dry.

The sets of mounted specimens are permanent, and with careful usage will last a long time. The supply of alcoholic material can be replenished from time to time at slight expense.

It is of great value to have a set of microscopical slides on which are mounted sections of the ovary so cut as to show the insertion of the ovules; also their parts and their arrangement. This is a subject of much importance in the study of systematic botany, and one involved in considerable difficulty. The fresh tissue of ovules is delicate, and by hardening in alcohol, imbedding, and making permanent microscopical mounts, a very profitable and interesting course of study may be arranged. If any teachers have occasion to use specimens for study during the season when flowers are not in bloom, they will find this method worth trying.—W. W. ROWLEE, *Cornell University.*

A Field Manual of Botany.—It is announced again that there will soon be issued a special edition of Gray's Manual for field use. It will be printed on thin French paper, with narrow margins. It will be bound in full leather, limp, and cut flush, very much like a foreign guide-book. The price will be two dollars, which is but a trifle more than for the ordinary edition. It will prove a useful book to students and collectors.—CHARLES E. BESSEY.